980

HAND SEWING OF MATERIAL FOR THE COVERING OF AIRPLANE SURFACES

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The following publication, entitled "Hand Sewing of Material for the Covering of Airplane Surfaces," is published for the information and guidance of all concerned.

[062.1, A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

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General, Chief of Staff.

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The Adjutant General.

Hand Sewing of Material for the Covering of Airplane Surfaces.

Fabrics, warp, and weft.

Warp consists of the threads running lengthwise in the fabric. Weft or filling consists of the threads running crosswise in the fabric. The different kinds of fabric used in covering airplane parts are: Irish linen, linen, silk, and cotton mixture, mercerized and unmercerized cotton.

Warp, weft, and tensile strength of cloth varies greatly. However, Irish linen should have a warp of 102 threads with a filling of 107 threads per square inch. Weight, 3¾ ounces per square yard. Tensile strength of fabric, 80 pounds per square inch.

Mercerized cotton must have at least 68 threads each for warp and weft per square inch, weight not more than 4 ounces per square yard, and tensile strength of not less than 50 pounds undoped or 70 pounds doped.

The long, white, sea-island cotton has been used extensively. This cotton has a long, strong fiber, and thrives best in the Bahama Islands and along the coast and on small islands near Georgia.

Making of leather patches.

Take a piece of rawhide leather, cut same to size 2½ by 5½ inches. Make two cuts clear through, 1 inch long and 1½ inches apart, across the length of the patch. Then sew patch to a piece of linen 6 inches wide and 9 inches long, double-stitching ¼ inch apart, either by hand or machine; if by hand, use linen thread. Fray the linen on all edges at least ¼ inch. This patch is placed on the horizontal stabilizer of Curtiss machine to protect stabilizer from elevator-control wires.

Take a piece of rawhide leather cut to size 2½ inches diameter. Sew same to a piece of linen 6 inches square, double-stitching. Make a cut 1 inch long in the center of the patch through the leather and the linen. Fray the linen on all edges ¼ inch. This patch is for the fuselage at the point where control wires go out to tail unit.

Take a piece of rawhide leather, cut same to size $1\frac{1}{2}$ by 3 inches. Take another piece of leather, cut same to size $2\frac{1}{2}$ by $1\frac{1}{2}$ inches square. Then sew this piece to the larger piece of leather with double-stitching $\frac{1}{4}$ inch wide, thus forming a loop in the center

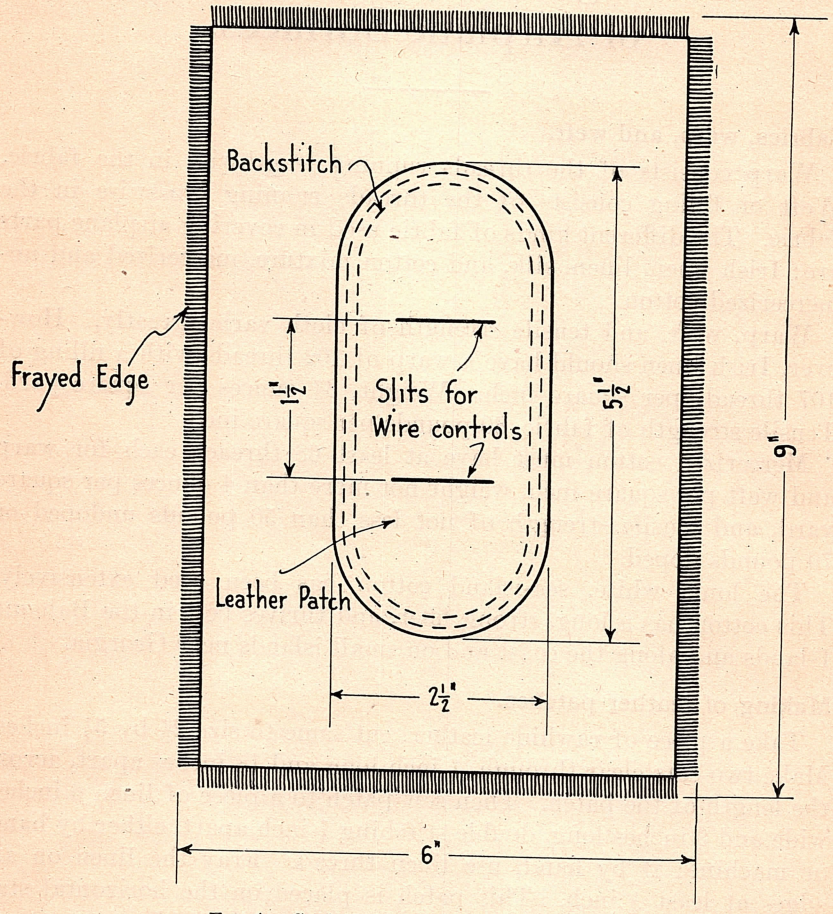


FIG. 1.—Control wire guide for stabilizer.

of the large piece. Then sew this to a piece of linen with double-stitching $\frac{1}{4}$ inch wide. The linen piece to be about $4\frac{1}{2}$ by 6 inches and frayed on all edges. This patch is used for control wires on the upper wing to keep them from rubbing on the wing and on stabilizer.

These patches vary in size and shape on different machines, but the fabric worker will get the general idea from the few given above.

Stitches used.

The four most common stitches used in covering are the backstitch, the overhand, the baseball, and the lock stitch.

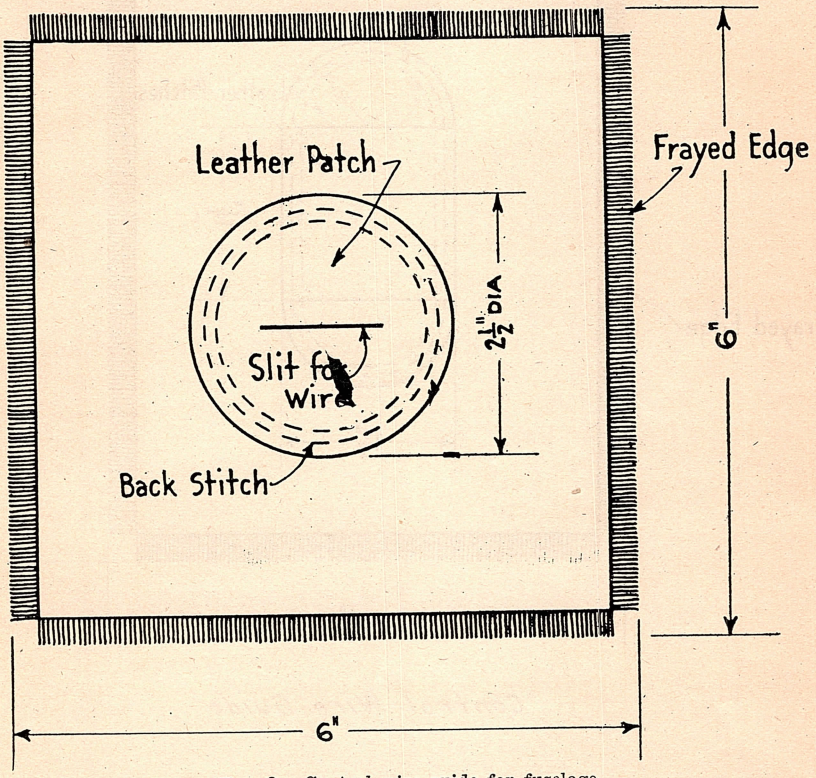
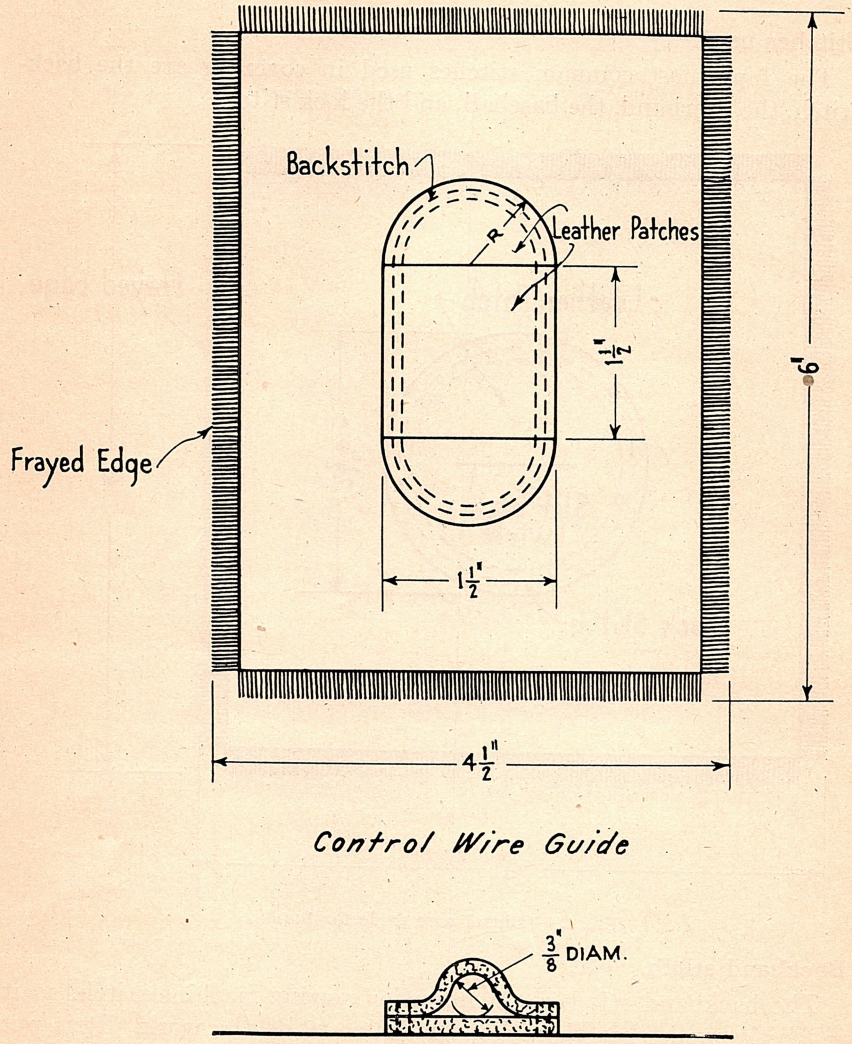


FIG. 2.—Control wire guide for fuselage.

Backhand stitch.

The backhand stitch is an imitation sewing-machine stitch, as it is mostly used when there is no machine to do the work. It is put $\frac{1}{2}$ inch from the edge of the fabric. The two pieces of cloth to be sewed together are placed evenly together and held by the left hand. The needle is pushed through the two layers of cloth and brought forward underneath about $\frac{3}{16}$ inch and pulled through on top, then the needle is set back of the thread $\frac{1}{8}$ inch and pushed through again

underneath, and the point of the needle brought up $\frac{1}{8}$ inch in front of the thread, then set back again $\frac{1}{8}$ inch and brought up $\frac{1}{8}$ inch



FIGS. 3, 4.—Patch used for control wires on the upper wing.

in front of the thread, and so on. Single thread will do. This kind of a seam is a good deal stronger than machine sewing, when done right, as it will not ravel.

Overhand stitching.

It is used on the edges of the fabric. In the first place, it is used in *overcasting* the edges of canvas or ducking in the making of propeller covers to prevent the cloth from raveling. But this stitch is

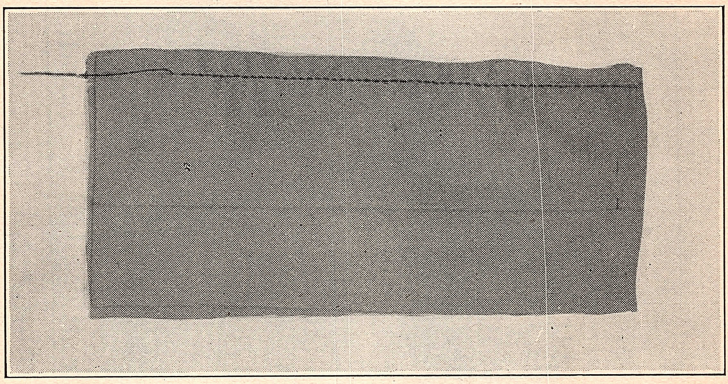


FIG. 5.—Backhand stitch.

mostly used in sewing together the edges on the coverings of airplane parts. The two edges of the cloth are turned in $\frac{1}{2}$ inch on each side and brought together. The point of the needle is placed between these two edges and the needle and thread pulled out toward

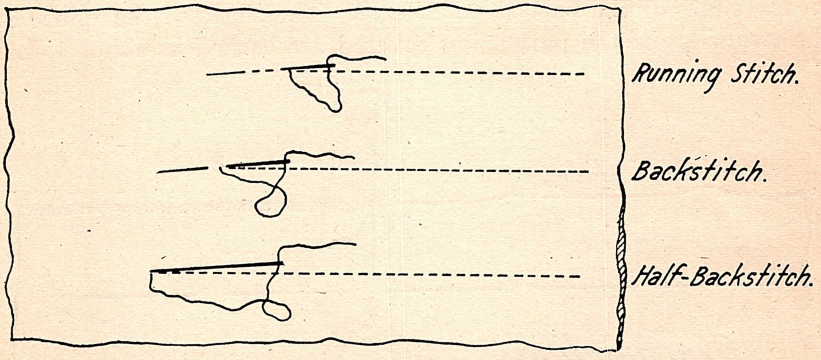


FIG. 6.—Illustrating the running stitch, backstitch, and half-backstitch.

the left, then brought over to the right side and put in straight opposite to the thread on the other side, $\frac{1}{16}$ inch from the edge. Then push diagonally across through the two edges, making a stitch about $\frac{3}{16}$ inch long, pull thread out, push in again on the right side

in the same manner ($\frac{1}{16}$ inch from edge, $\frac{3}{16}$ inch diagonally across the edges toward the left), pull out.

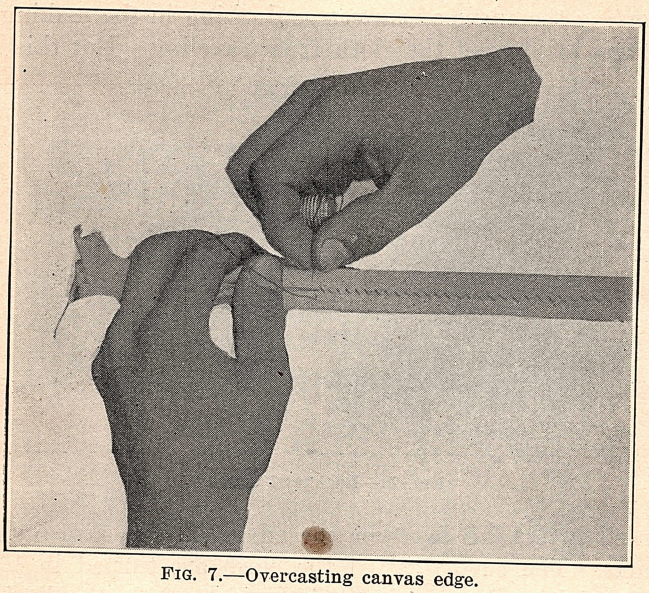


FIG. 7.—Overcasting canvas edge.

Baseball stitch.

The baseball or zigzag stitch is also used to sew the fabric together on the edges of the part to be covered. The edges of the fabric on the two sides of the part being covered are turned in about $\frac{1}{2}$ inch

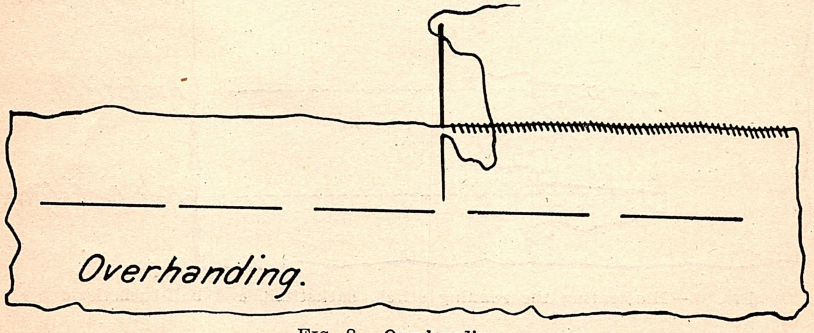


FIG. 8.—Overhanding.

and left about $\frac{1}{4}$ inch apart, to be pulled together by the baseball stitches, which are made in this manner: The point of the needle is placed between the two layers of the cloth, and put in about $\frac{1}{16}$ inch

from the edge and then pulled out on the left. The needle is again placed in between the two edges, pushed out from the inside *to the right* $\frac{3}{16}$ inch ahead of the first stitch, and so on. From the inside of the two edges of fabric the needle is pushed out to the right, then to the left. By using strong thread and drawing the edges of the fabric

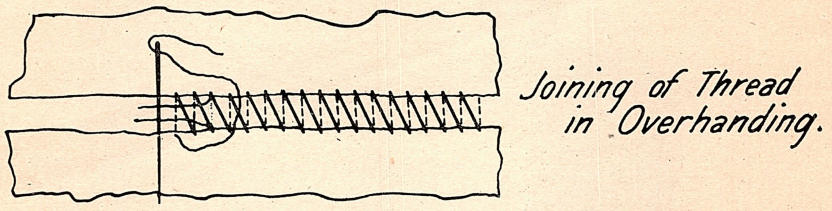


FIG. 9.—Joining of thread in overhanding.

together you are giving the covering an additional stretch and also finishing up a fine, smooth surface on the edge of the part covered.

Lock stitches.

Lock stitches are tied stitches taken through the material or fabric, and around the rib formation of the part covered, for the purpose of holding it in contact with the rib firmly and tightly. In making

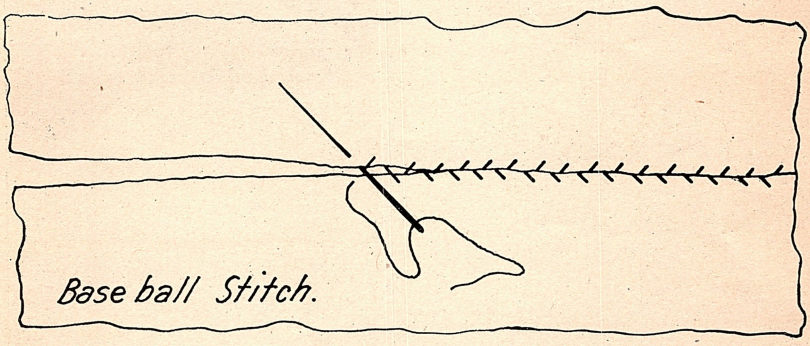


FIG. 10.—Baseball or zigzag stitch.

these stitches use a special lock-stitch needle and No. 8 flax thread or twine. Put them about 4 or 5 inches apart and about 3 inches from the edge. See to it that the thread or twine is about $2\frac{1}{2}$ times as long as the rib to go over, as the stitches should not be spliced. When the needle and thread is ready, put it through on the right side of the rib as close as possible, starting at the thickest part which is to be

covered; push the needle up on the left side of the rib, tie a knot as a starter, then push through on the right side and then up on the

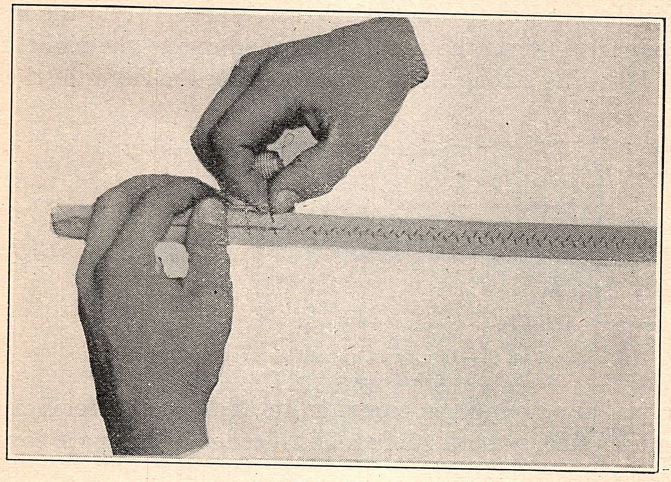


FIG. 11.

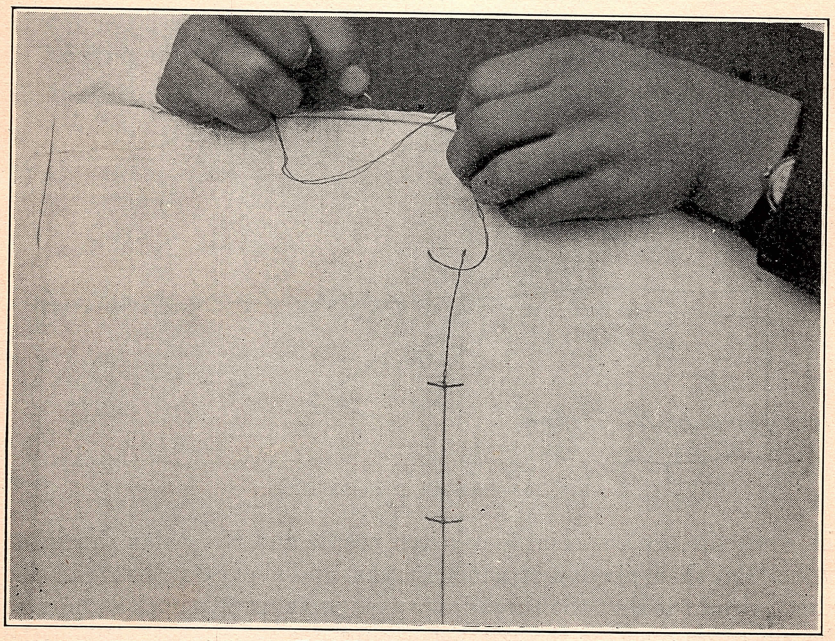


FIG. 12.—Lock stitching.

left side of the rib, pull the thread through, pick up thread and form a hitch, then put needle diagonally through underneath the hitch and

then form a loop. Hold the thread securely with the left hand and place first finger of the left hand over knot now being tied, while

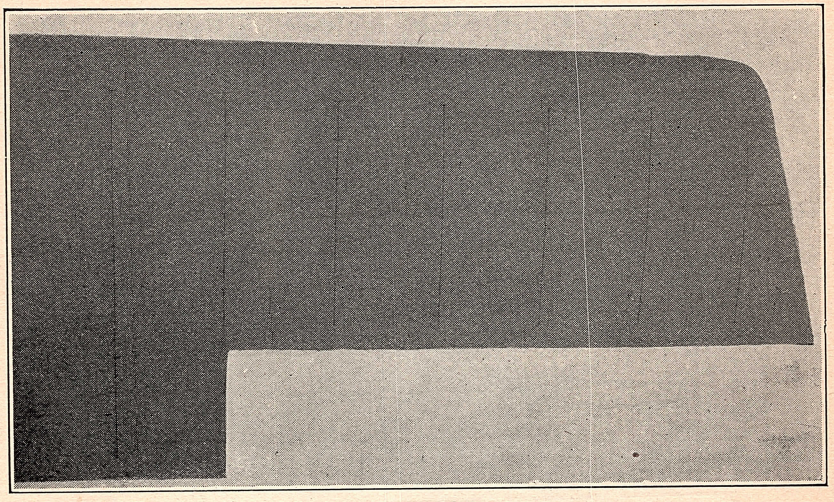


FIG. 13.—Lock-stitched wing covering.

pulling out with your right hand. Pull the knot tight and be sure to get them all straight and even.

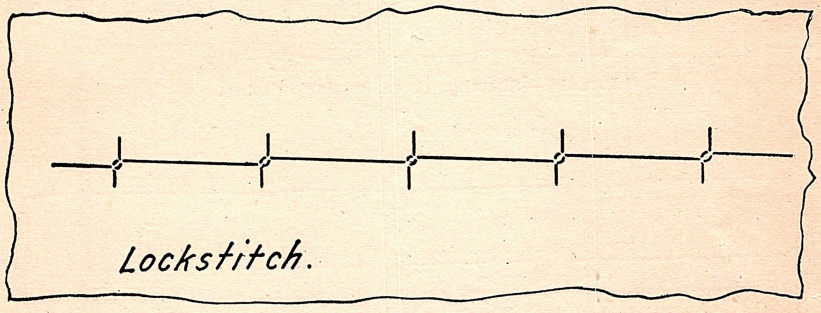


FIG. 14.—Lockstitch.

Kind of tacks used.

Brass, copper, and lace enameled tacks are used to tack the fabric in place. They will not rust under exposure to moisture, thereby rotting and weakening the cloth.

To cover a fuselage.

In covering the fuselage either one of two methods may be used—first, tacking cover on sides and bottom separately; second, cutting

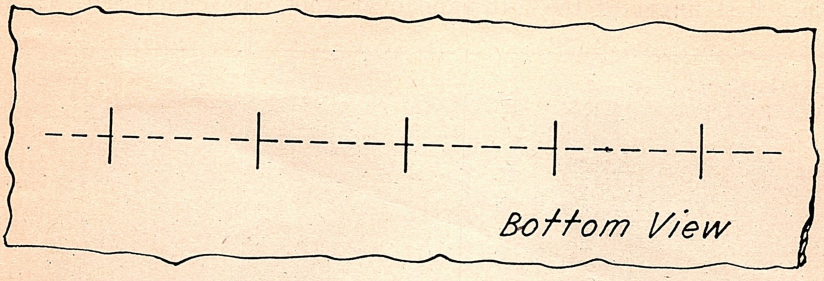


FIG. 15.—Bottom view of lock stitch.

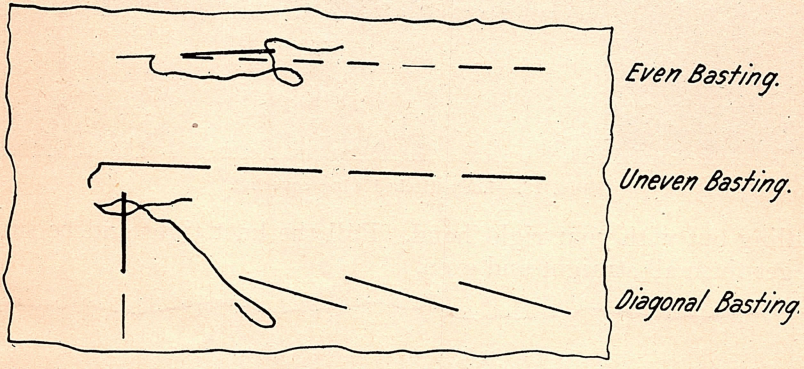


FIG. 16.—Showing three basting stitches.

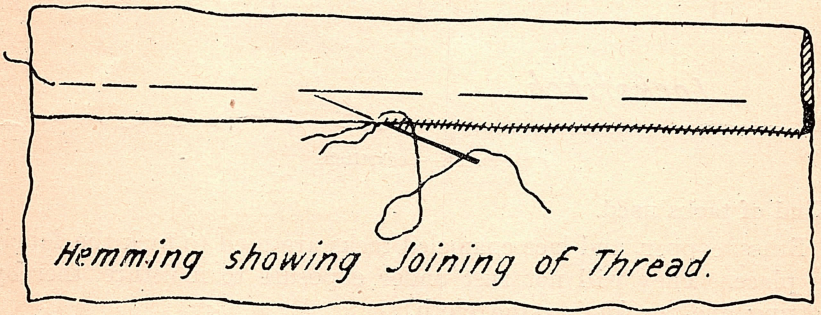


FIG. 17.—Hemming—showing joining of thread.

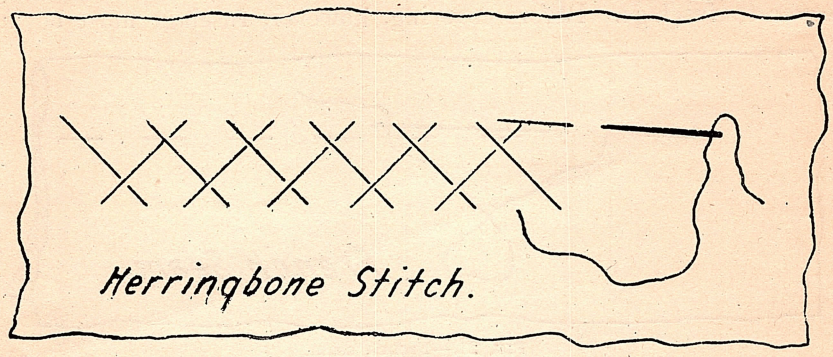


FIG. 18.—Herringbone stitch.

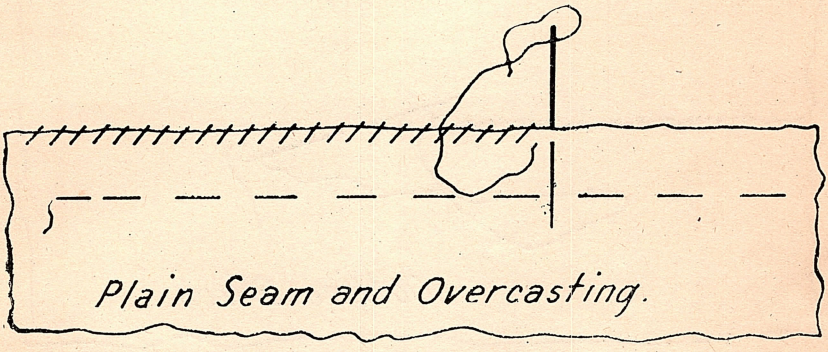


FIG. 19.—Plain seam and overcasting.

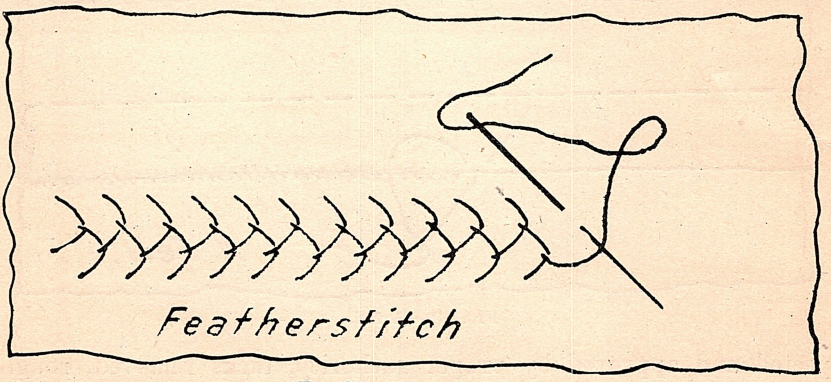


FIG. 20.—Featherstitch.

cloth according to pattern, sewing sides to bottom, and then tacking cover to fuselage. Before covering, however, fuselage must be in-

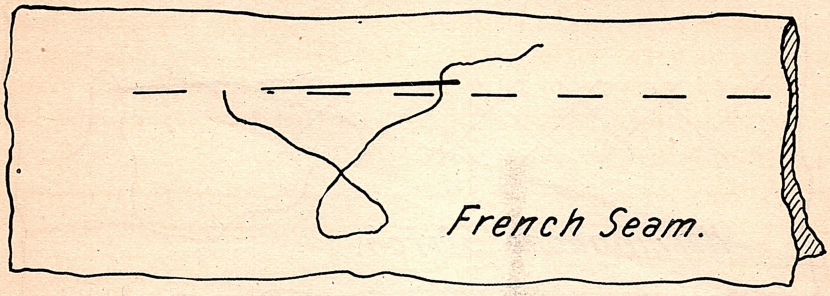


FIG. 21.—French seam.

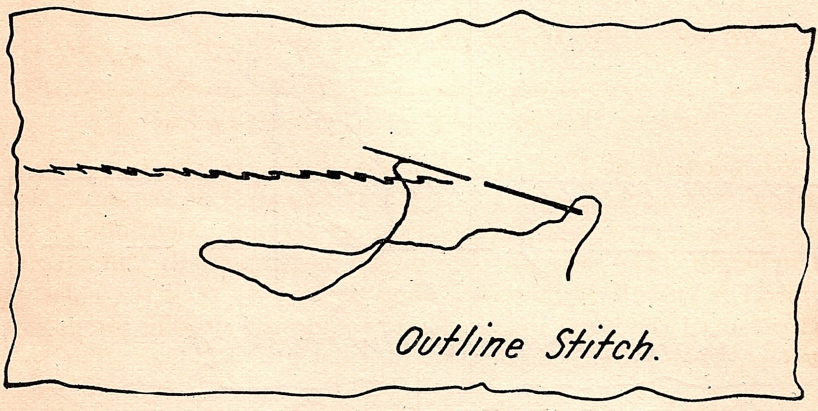


FIG. 22.—Outline stitch.

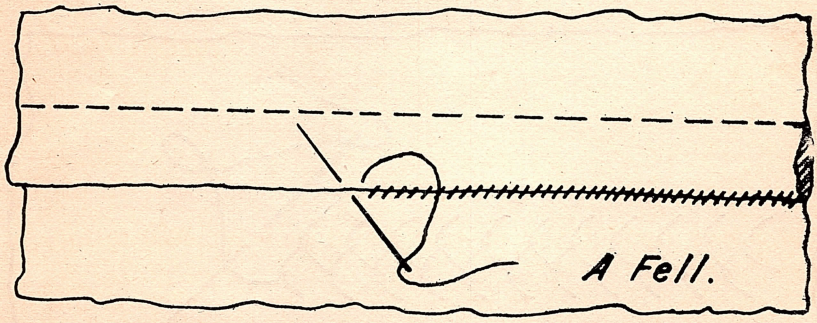


FIG. 23.—A fell.

spected and approved by proper authority, tacks removed, rough surfaces made smooth, and all metal parts that may touch fabric

padded with double thickness of canvas. Tack cloth to longeron on bottom side first. If width of cloth permits the only measurement that need be taken is the length. This is found by measuring from tail post to metal engine cover. This measurement, plus tacking allowances at each end of 1½ inches, will give length of strips. After cutting cloth, take bottom strip and tack on temporarily and cut off surplus material.

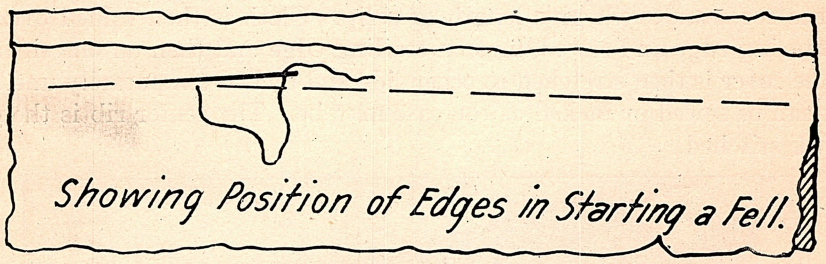


FIG. 24.—Showing position of edges in starting a fell.

Then starting at front end tack fabric toward the tail post of fuselage, first back on one side part way and then on the other side same distance, stretching fabric to proper tension. Continue so for entire length. The sides are then tacked on temporarily and surplus material is cut off at bottom. Then proceed to tack the sides to the bottom of the lower longerons, stretching the cloth to the proper tension. This work is done with fuselage upside down. The ma-

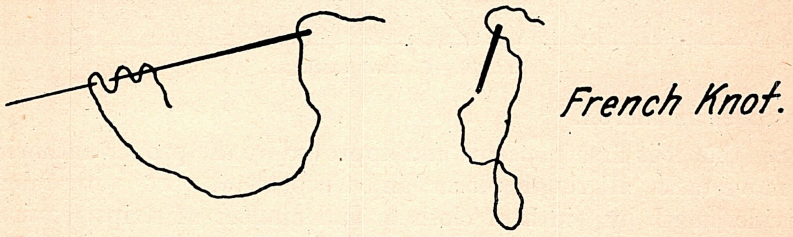


FIG. 25.—French knot.

chine is now righted, and the side coverings are tacked to tops of upper longerons.

When sides are sewed to bottom cloth must be cut according to pattern. Patterns for sides and bottom are so made that the machine seams come in center of bottom longerons. The same method is used in tacking and stretching as was mentioned above, or in tacking method, except that bottom is tacked only temporarily. Stirrup

holes are cut after the cloth is tacked. Wing hinge fitting holes are cut before cloth is tacked and are properly reinforced.

To cover center section.

See that it is first inspected by the proper authority. Tacks are then removed, rough places made smooth and metal parts properly wrapped. Generally one width of cloth is sufficient to cover same. The circumference is then taken and that measurement, plus allowance for seams, will give length of strip. Cloth is then folded over entering edge and sewed, first on trailing edge and then on one side. The cover is then stretched to other side and tacked temporarily until it can be sewed or tacked as the case may be. The center rib is then lock stitched.

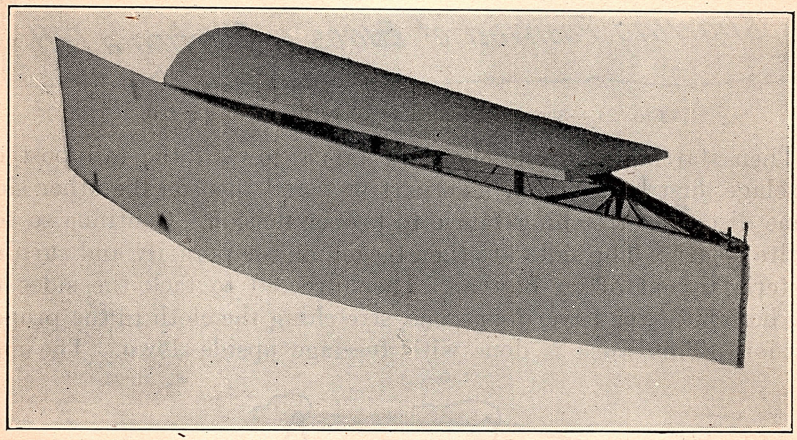


FIG. 26.—Covered fuselage.

To cover an aileron.

See that it is first inspected and approved by the proper authority. Remove tacks, all rough places, and wrap metal parts with fabric. Divide length by width of cloth to find number of strips required. Find circumference, plus allowance, for seams to find right length of each strip. Machine sew these strips together. Fold cloth over entering edge and sew by hand on trailing edge and curved end. Stretch to other end, and tack temporarily and sew by hand. The ribs are then lock stitched.

To cover an inspection cover or turtle back.

See that it is first inspected and approved by the proper authority. Remove all tacks. Rough places must be made smooth; sandpaper

may be used for this purpose. If cloth is wide enough, cut it to proper length and tack on, first front and back, then the sides, drawing cloth to proper tension. Cut away surplus material. If cloth is not sufficiently wide, cut two strips of proper length, sew together lengthwise, either by hand or machine, tack front first, then sides, cutting away surplus material, then tack at the back. When tacking always pull cloth to proper tension.

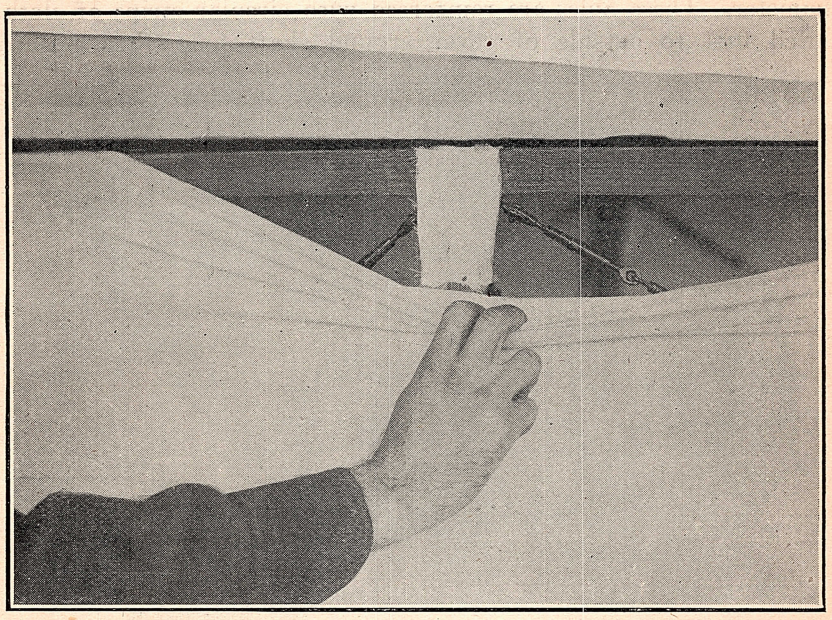


FIG. 27.—Double-canvas padding over metal parts.

To cover an elevator.

See that it is first inspected for alignment and construction and approved by the proper authority. Remove all tacks. Rough places must be made smooth. Use sandpaper for this purpose. Cover all metal parts with fabric. If cloth is wide enough, cut proper length, sew two pieces together lengthwise, fold over leading edge, clasp or pin at trailing edges, cutting away surplus material. If cloth is not sufficiently wide, cut and sew together two strips, fold over leading edge so that the seam extends around elevator, parallel with the vertical ribs, pin or clasp and sew around trailing edge, cutting away surplus material. Use baseball stitch or overhand stitch. Then put in lock stitches around the ribs. Another method used is to lay ele-

vator over cloth, mark around trailing edge, allowing for seaming, cut out material, sew together around trailing edge, slip on over elevator same as a bag, and sew or tack along leading edge.

To cover a wheel.

Cut out two circular pieces of cloth same diameter as wheel from rim to rim, allowing ¾ inch on edges for draw-string loop and clinching allowance. Cut out centers for shaft holes 2 inches in diameter. These holes are reinforced with circular strips of cloth, sewed first to outside of cover around shaft hole, then pushed

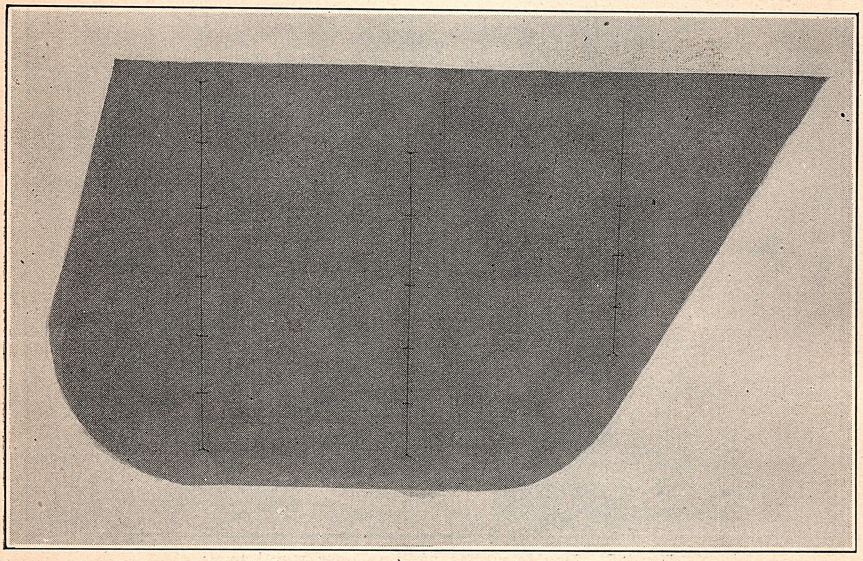


FIG. 28.—Covered elevator.

through shaft hole, turned back and sewed under side of cover. In one of these pieces of cloth, a handhole for reaching valve and oil cup is cut 3½ inches in diameter and reinforced in same manner as center shaft hole. Centers of shaft hole and handhole should be 5½ inches apart. Draw strings are placed within the outside loop allowance so that the fabric may be drawn tightly over the wheel. Above description is for a wheel on L. W. F. machine, although this process is identical on many other machines.

To cover a rudder.

See that it is first inspected and approved by the proper authority. Remove rough places. Cover all metal parts with fabric. If cloth

is wide enough, two pieces proper length are cut out and sewed lengthwise, folded over leading edge and sewed along trailing edge, cutting away surplus material. Lockstitches are then sewed around the ribs. If the cloth is sewed by machine, use pattern or form, mark and cut out cloth, sew around trailing edge, slip over rudder as a bag, and sew by hand along leading edge. Cloth can not be tacked along leading edge as this edge on rudder is metal.

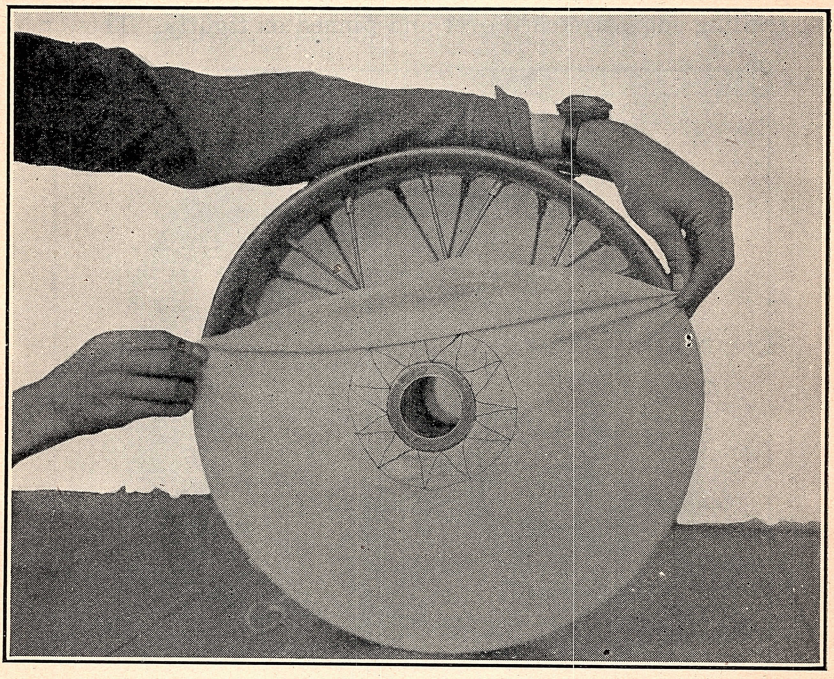


FIG. 29.—Stream lining a wheel.

How to cover wings—Overlap method.

Before covering the framework of a wing smooth out all places with sandpaper and remove all tacks. Cover all metal parts with pieces of cloth and wrap all metal edges. The corner in the trailing edge into which the aileron fits is reinforced with a double piece of fabric tacked on, on both sides, leaving the center part of the square formation perfectly smooth and even. Measure the side of the wing; the length and the width or the circumference. The circumference of a wing or aileron is taken as the measurement around the entire outer surface. As the cloth is usually put on parallel with the width of the wing, or rather in line with the drift

of airplane, the measure of the circumference of the wing will give the length of the cloth strips needed, while the measure of the length of the wing will determine the number of strips needed.

After the proper lengths of cloth are cut they are sewed together on the machine, making a ½-inch seam, which is then stitched down with a double stitch ½ inch wide. After the cover is sewed together, the center line of same is then placed over the entering edge of the wing and the two ends or sides of the cloth brought together over the trailing edge, stretched over and pinned on tightly. These parts

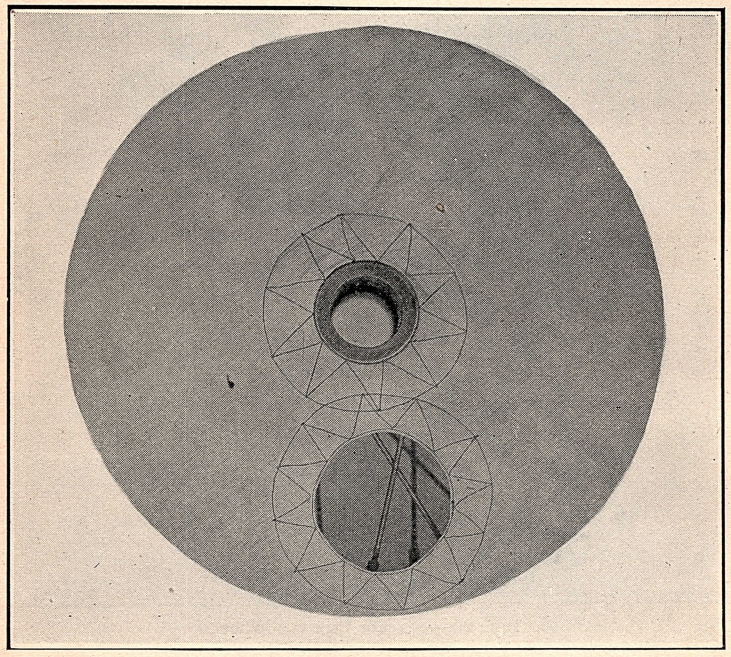


FIG. 30.—Stitching around holes in wheel cover.

are then sewed together by hand, using either overhand or baseball stitches.

After the trailing edge is sewed the center part of the wing is temporarily tacked down across on both sides and the covering pulled tightly toward the ends, where it is temporarily tacked down on the edge. The cloth is then folded in and sewed together on the ends. Where there are metal fittings, tack the fabric down, folded in around same. After covering is sewed all around the wing, lock stitches are put on over the ribs 4 inches apart and 3 inches from the edge. This being done, the wing is ready for the dope room.

Vertical stabilizer—How covered.

First reinforce and wrap all metal parts and edges with pieces of fabric. Take a pattern, drafted according to measurements, and cut the cloth according to same; if necessary to put in a seam be sure to get same in line with the drift of the plane. Sew one edge of the covering together on machine or by hand, using backhand stitch, then fold cloth over and fasten it tightly on the other side edges, then sew together by hand. Be sure to get the cloth on tight and even. After cloth is sewed on, lockstitch ribs in parallel with drift.

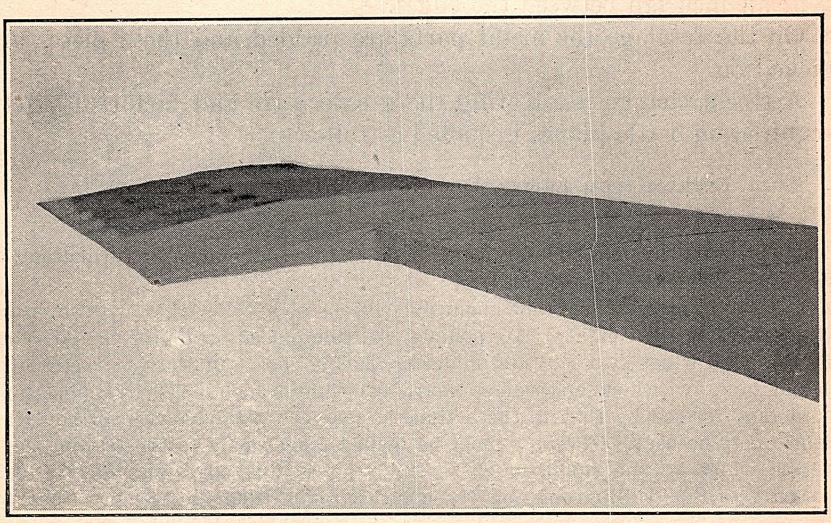


FIG. 31.—Reinforced corner for aileron cover.

Horizontal stabilizer—How covered.

Before covering horizontal stabilizer prepare for covering in the usual manner, then find length and divide width of cloth, less seam allowance, to find number of strips. The circumference, plus the seam allowance, will give the length of the strips. Machine sew the strips together, fold cover over trailing edge, and sew one curved end and trailing edge by hand. Then proceed to stretch fabric to other end, tack temporarily to last rib on both sides and complete the sewing. Another method is to fold cover over entering edge, sew up curved ends, stretch fabric to trailing edge and tack temporarily until properly sewed. The ribs are lock stitched 4 inches apart.

Covering of all metal parts.

All metal parts, fittings, and edges of any part of the airplane are always wrapped or soldered before covering is put on; as a rule for these pieces use same material as that from which the covering is made. The purpose of this padding and wrapping is to protect the cloth covering from wear and from rust. The wrapping should be doped or glued on, and especially the pieces put on the metal parts. In the classroom we sew or tack on these wrappings; however, it is best to fasten them on with stitches. The metal edges are wrapped with breaker strips, which are put on with a spiral wrap and about ¾ of an inch lap between the edges.

On the fuselage the metal parts are padded and these pieces are tacked on.

A recent change illustrating the greater care and factor of safety required on battle planes is quoted as follows:

EXTRACT FROM LETTER, DIRECTOR OF MILITARY AERONAUTICS.

* * * * * * *

1. The following method for attaching fabric on airplanes is furnished for your information:

2. A reinforcing selvage tape about five-eighths inch (⅝″) wide, with a tensile strength of at least eighty (80) pounds, shall be placed on top of the covering fabric of all wings over ribs and under the lacing cord. In place of the eighty-pound tape, two thicknesses of standard five-eighths inch (⅝″) wrapping tape or a tape formed by folding three times a two-inch straight strip of covering fabric may be used. The tape must be tacked temporarily to the trailing edge of the wings on one side, brought around the leading edge, and tacked temporarily to the trailing edge on the opposite side. The facing must then be sewed over the selvage tape and tied with a double half-hitch knot at each stitch. The intervals between lacing points in the slip stream and as far out as the ailerons should be about two and a quarter inches (2¼″). Beyond this, the intervals between lacings must not be more than four inches (4″). After sewing, all tacks must be removed by pulling and not by knocking out.

3. It is recommended that this method be used on all machines other than training at stations which are under your supervision.

4. Careful attention should be paid to the conditions of the fabric, and at the first sign of looseness the plane should be re-covered.

By direction of Maj. Gen. Kenly:

W. J. FITZMAURICE,
Major, Air Service,
Flying Executive, Operations Section.

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